WHAT IS CLAIMED IS:

1. A method for treating a sample to acquire multidimensional spectra within a single scan comprising the steps of: (1) partitioning a sample into a set of independent subensembles endowed with different resonance frequencies; (2) implementing a polychromatic irradiation of the sample whereby the various subensembles are selectively manipulated by a time-incremented series of excitation or refocusing sequences; (3) generating an observable spectral signal from each of the subensembles; (4) simultaneously monitoring the observable signals arising from the set of subensembles in a resolved fashion; (5) processing the observable signals acquired in this manner into a complete multidimensional spectral data set.
2. The method for treating a sample according to claim 1 wherein step (3) includes applying to the subensembles a homogeneous sequence.
3. The method of claim 1 wherein the partitioning effected during the excitation and acquisition periods is effected notionally.
4. The method of claim 1 wherein the polychromatic irradiation and the resolved fashion is selected to suit the particular kind of spectroscopy associated with the spectral data set.
5. The method of claim 4 wherein the spectroscopy includes one of optical, paramagnetic electron, mass and nuclear magnetic resonance (NMR) origin.
6. The method of claim 1 wherein the scan is completed in 1 second.
7. The method of claim 1 wherein the scan is completed in about 0.1 seconds.
8. The method of claim 1 wherein the homogenous sequence is in the form of a pulse.
9. The method of claim 1 wherein the homogenous sequence is in the form of a series of impulses.
10. The method of claim 1 in which magnetic field gradients are used for excitation, refocusing, and resolved acquisition.
11. The method of claim 1 wherein a spatial encoding of the resonance frequencies is effected.
12. The method of claim 1 wherein the single scan is repeated a preselected number of times to obtain a plurality of complete multidimensional spectral data sets.

13. A method for treating a sample to acquire multidimensional magnetic resonance spectra within a single scan comprising the steps of: (1) applying a magnetic field gradient on the sample so as to endow spins at different positions within the sample with different resonance frequencies; (2) applying a train of frequency-selective radiofrequency (RF) pulses in unison with this gradient so as to endow spins at different positions within the sample with incremented values of their evolution times, thus creating an effective spatial encoding of the spins' frequencies (3) creating a set of observable spin signals; (4) capturing the signals thus created from the sample while decoding the spins' spatial locations using a second set of acquisition magnetic field gradient; (5) subjecting the collected data to a suitable rearrangement and Fourier analysis procedure so as to retrieve the final spectrum being sought.
14. The method of claim 13 wherein the magnetic field gradient oscillates.
15. The method of claim 13 wherein steps (1) to (4) are repeated a small number of times.
16. The method of claim 13 wherein step (3) includes applying a homogeneous mixing pulse sequence at the conclusion of the spatial encoding.
17. The method of claim 13 wherein the scan is completed in 1 second.
18. The method of claim 13 wherein the scan is completed in about 0.1 seconds.
19. The method of claim 13 wherein step (1) is carried out using multiple linearly-independent gradient geometries.
20. The method of claim 13 wherein step (5) includes digitizing of the collected data prior to Fourier analysis.
21. The method of claim 13 wherein step (2) is carried out using a single 90 degree excitation followed by a train of spatially selective 180 degree refocusing pulses.
22. The method of claim 13 wherein step (2) is carried out using a single chirp excitation pulse.
23. The method of claim 13 wherein step (2) is carried out by a first train of frequency-selective radiofrequency (RF) pulses to create a first spatial encoding along one direction followed by a second train of frequency-selective radiofrequency (RF) pulses to create additional spatial encodings along different direction.

24. The method of claim 13 wherein step (2) is carried out by a first train of frequency-selective radiofrequency (RF) pulses to create a first spatial encoding along one direction followed by a second train of frequency-selective radiofrequency (RF) pulses to create additional spatial encodings along a different geometry.

25. The method of claim 13 wherein step (2) is carried out by a first train of frequency-selective radiofrequency (RF) pulses to create a first spatial encoding along one direction followed by a second train of frequency-selective radiofrequency (RF) pulses to create additional spatial encodings along a different direction and geometry.

26. The method of claim 13 wherein step (2) is carried out by a first train of frequency-selective radiofrequency (RF) pulses to create a first spatial encoding along one direction followed by additional trains of frequency-incremented radiofrequency (RF) pulses to create additional spatial encodings along different directions.

27. The method of claim 13 wherein step (2) is carried out by a first train of frequency-selective radiofrequency (RF) pulses to create a first spatial encoding along one direction followed by additional trains of frequency-selective radiofrequency (RF) pulses to create additional spatial encodings along different geometries.

28. The method of claim 13 wherein step (2) is carried out by a first train of frequency-selective radiofrequency (RF) pulses to create a first spatial encoding along one direction followed by additional trains of frequency-selective radiofrequency (RF) pulses to create additional spatial encodings along different directions and geometries.

29. The method of claim 13 wherein multiple distinctive spatial encodings are created.

30. The method of claim 13 wherein spatially-localized MRI information is retrieved in combination with multidimensional NMR spectra by means of further numerical manipulations on the single scan (or few scans) data.

31. A method for the real-time monitoring of a chemical or biochemical process comprising the steps of: (1) conducting a chemical or biochemical process in real-time; (2) monitoring the on-going chemical or biochemical process in real time by

repeatedly acquiring a series of multidimensional spectra within a single scan implemented at preselected short time intervals; each single scan being carried out comprising the steps of: (3) partitioning, at least notionally, a sample of the on-going chemical process into a set of independent subensembles; (4) applying the single scan to the sample by exciting the set of subensembles by a time-incremented series of polychromatic sequences; (5) generating a signal from each subensemble with a final, homogeneous sequence; (6) simultaneously acquiring the subensemble-resolved spectral signals for each preselected short time interval; and (7) processing such series of signals into a series of multidimensional spectra, so as to visualize the nature of the chemical or biochemical process in a real time fashion.

32. A method for the real-time monitoring of hyperpolarized spin states comprising the steps of: (1) generating very highly polarized spin states in a sample in real-time; (2) monitoring the on-going very highly polarized spin states in the sample in real time by repeatedly acquiring a series of multidimensional spectra within a single scan implemented at preselected short time intervals; each single scan being carried out comprising the steps of: (3) partitioning, at least notionally, the sample containing the on-going very highly polarized spin states into a set of independent subensembles; (4) applying the single scan to the sample by exciting the set of subensembles by a time-incremented series of frequency-shifted sequences; (5) generating a signal from each subensemble with a final, homogeneous sequence; (6) simultaneously acquiring the subensemble-resolved spectral signals for each preselected short time interval; and (7) processing such series of signals into a series of multidimensional spectra, so as to visualize the nature of the very highly polarized spin states in the sample in a real time fashion.

33. A method for the real-time monitoring of an analyte flowing through a spectrometer comprising the steps of: (1) monitoring an on-going chromatographic process in real time by repeatedly acquiring a series of multidimensional spectra within a single scan implemented at preselected short time intervals; each single scan being carried out comprising the steps of: (2) partitioning, at least notionally, a sample of the analyte of the on-going chromatographic process into a set of independent subensembles; (3) applying the single scan to the sample by exciting the set of subensembles by a time-

incremented series of polychromatic sequences; (4) generating a signal from each subensemble with a final, homogeneous sequence; (5) simultaneously acquiring the subensemble-resolved spectral signals for each preselected short time interval; and (6) processing such series of signals into a series of multidimensional spectra, so as to visualize the nature of the analyte in a real time fashion.

34. A method for the real-time monitoring a combinatory chemical process comprising the steps of: (1) monitoring an on-going combinatory chemical process in real time by repeatedly acquiring a series of multidimensional spectra within a single scan implemented at preselected short time intervals; each single scan being carried out comprising the steps of: (2) partitioning, at least notionally, a sample of the on-going combinatory chemical process into a set of independent subensembles; (3) applying the single scan to the sample by exciting the set of subensembles by a time-incremented series of polychromatic sequences; (4) generating a signal from each subensemble with a final, homogeneous sequence; (5) simultaneously acquiring the subensemble-resolved spectral signals for each preselected short time interval; and (6) processing such series of signals into a series of multidimensional spectra, so as to visualize the nature of the combinatory chemical process in a real time fashion.

35. A method for the real-time control of a quantum computing process with respect to a sample comprising the steps of: (1) monitoring an on-going quantum computing process in real time by repeatedly acquiring a series of multidimensional spectra within a single scan implemented at preselected short time intervals; each single scan being carried out comprising the steps of: (2) partitioning, at least notionally, a sample correlated with the activity of the on-going quantum computing process into a set of independent subensembles; (3) applying the single scan to the sample by exciting the set of subensembles by a time-incremented series of polychromatic sequences; (4) generating a signal from each subensemble with a final, homogeneous sequence; (5) simultaneously acquiring the subensemble-resolved spectral signals for each preselected short time interval; and (6) processing such series of signals into a series of multidimensional spectra, so as to visualize the nature of the quantum computing

process in a real time fashion, and (7) using the series of multidimensional spectra to control the operation of the quantum computing process.

36. A method for the real-time elucidation of molecules comprising the steps of: (1) acquiring a series of multidimensional spectra within a single scan implemented at a preselected short time interval; said single scan being carried out comprising the steps of: (2) partitioning, at least notionally, a sample of a target molecule into a set of independent subensembles; (3) applying the single scan to the sample by exciting the set of subensembles by a time-incremented series of polychromatic sequences; (4) generating a signal from each subensemble with a final, homogeneous sequence; (5) simultaneously acquiring the subensemble-resolved spectral signals for said preselected short time interval; and (6) processing said signals into a multidimensional spectra, so as to visualize the nature of the molecule in a real time fashion.

37. A method for conducting in real-time *in vivo* spectroscopy comprising the steps of: (1) repeatedly acquiring a series of multidimensional spectra within a single scan implemented at a preselected short time interval; each single scan being carried out comprising the steps of: (2) partitioning, at least notionally, an *in vivo* sample into a set of independent subensembles; (3) applying the single scan to the sample by exciting the set of subensembles by a time-incremented series of polychromatic sequences; (4) generating a signal from each subensemble with a final, homogeneous sequence; (5) simultaneously acquiring the subensemble-resolved spectral signals for said preselected short time interval; and (6) processing such series of signals into a series of multidimensional spectra, so as to visualize the nature of the *in vivo* sample in a real time fashion.

38. A method for the real-time monitoring of an MRI protocol comprising the steps of: (1) monitoring an on-going MRI protocol in real time by repeatedly acquiring a series of multidimensional spectra within a single scan implemented at preselected short time intervals; each single scan being carried out comprising the steps of: (2) partitioning, at least notionally, a sample of the object of the MRI protocol on-going into a set of independent subensembles; (3) applying the single scan to the sample by exciting the set of subensembles by a time-incremented series of frequency-shifted sequences; (4) generating a signal from each subensemble with a final, homogeneous sequence; (5) simultaneously acquiring

the subensemble-resolved spectral signals for each preselected short time interval; and (6) processing such series of signals into multidimensional spectra, so as to visualize the nature of the on-going MRI protocol in a real time fashion.

39. A method for enhancing the sensitivity of unidimensional heteronuclear acquisitions comprising the steps of: (1) partitioning, at least notionally, a sample into a set of independent subensembles; (2) endowing each subensemble with a time-incremented series of evolutions utilizing polychromatic sequences in combination with field gradients; (3) transferring the encoded information back to more sensitive NMR nuclei such as protons for the sake of enhancing the sensitivity of the detection; (4) generating a coherent signal from the heteronuclei by applying a suitable sequence on the more sensitive nucleus; and (6) processing such series of signals into the desired spectrum, so as to visualize the NMR behavior of the low frequency heteronucleus with the sensitivity of the directly detected spin.

40. A method for compensating magnetic field inhomogeneities or magnetic field instabilities comprising the steps of: (1) partitioning, at least notionally, a sample into a set of independent subensembles; (2) endowing each subensemble with a time-incremented series of evolutions utilizing polychromatic sequence; (3) correcting the static or dynamic distortions in magnetic field ideality by compensating this information, mapped prior to the experiment's execution and/or in a real-time fashion, by a suitable manipulation of the radiofrequency (RF) phases involved in the polychromatic irradiation; (4) generating a coherent signal from all nuclei in the sample thus devoid from the deficiencies in magnetic field; (6) process such series of signals into the desired high resolution uni- or multi-dimensional NMR spectra.

41. Apparatus for treating a sample to acquire multidimensional spectra within a single scan comprising (1) means for partitioning a sample into a set of independent subensembles endowed with different resonance frequencies; (2) means for implementing a polychromatic irradiation of the sample whereby the various subensembles are selectively manipulated by a time-incremented series of excitation or refocusing sequences; (3) means for generating an observable spectral signal from each of the subensembles; (4) means for simultaneously monitoring the observable signals arising from the set of subensembles in a

resolved fashion; and (5) means for processing the observable signals acquired in this manner into a complete multidimensional spectral data set.

42. The apparatus for treating a sample according to claim 41 wherein the means for generating an observable spectral signal includes means for applying to the subensembles a homogeneous sequence.
43. The apparatus of claim 41 wherein the partitioning effected during the excitation and acquisition periods is effected notionally.
44. The apparatus of claim 41 wherein the polychromatic irradiation and the resolved fashion is selected to suit the particular kind of spectroscopy associated with the spectral data set.
45. The apparatus of claim 44 wherein the spectroscopy includes one of optical, paramagnetic electron, mass and nuclear magnetic resonance (NMR) origin.
46. The apparatus of claim 41 wherein the scan is completed in 1 second.
47. The apparatus of claim 41 wherein the scan is completed in about 0.1 seconds.
48. The apparatus of claim 41 wherein the homogenous sequence is in the form of a pulse.
49. The apparatus of claim 41 wherein the homogenous sequence is in the form of a series of impulses.
50. The apparatus of claim 41 in which magnetic field gradients are used for excitation, refocusing, and resolved acquisition.
51. The apparatus of claim 41 wherein a spatial encoding of the resonance frequencies is effected.
52. The apparatus of claim 41 wherein the single scan is repeated a preselected number of times to obtain a plurality of complete multidimensional spectral data sets.
53. Apparatus for treating a sample to acquire multidimensional magnetic resonance spectra within a single scan comprising (1) means for applying a magnetic field gradient on the sample so as to endow spins at different positions within the sample with different resonance frequencies; (2) means for applying a train of frequency-selective radiofrequency (RF) pulses in unison with this gradient so as to endow spins at different positions within the sample with incremented values of their evolution times, thus creating an effective spatial encoding of the spins' frequencies (3) means for creating a set of observable spin signals; (4) means for

capturing the signals thus created from the sample while decoding the spins' spatial locations using a second set of acquisition magnetic field gradient; and (5) means for subjecting the collected data to a suitable rearrangement and Fourier analysis procedure so as to retrieve the final spectrum being sought.

54. Apparatus of claim 53 wherein the magnetic field gradient oscillates.
55. Apparatus of claim 53 further including means for repeating the scan a small number of times.
56. Apparatus of claim 53 including means for applying a homogeneous mixing pulse sequence at the conclusion of the spatial encoding.
57. Apparatus of claim 53 wherein the scan is completed in 1 second.
58. Apparatus of claim 53 wherein the scan is completed in about 0.1 seconds.
59. Apparatus of claim 53 wherein means are provided for using multiple linearly-independent gradient geometries.
60. Apparatus of claim 53 wherein means are provided for digitizing of the collected data prior to Fourier analysis.
61. Apparatus of claim 53 wherein said means for applying a train of frequency-selective radiofrequency (RF) pulses is carried out using a single 90 degree excitation followed by a train of spatially selective 180 degree refocusing pulses.
62. Apparatus of claim 53 wherein the means for applying a train of frequency-selective radiofrequency (RF) pulses is carried out using a single chirp excitation pulse.
63. Apparatus of claim 53 wherein the means for applying a train of frequency-selective radiofrequency (RF) pulses is carried out by a first train of frequency-selective radiofrequency (RF) pulses to create a first spatial encoding along one direction followed by a second train of frequency-selective radiofrequency (RF) pulses to create additional spatial encodings along different direction.
64. Apparatus of claim 53 wherein the means for applying a train of frequency-selective radiofrequency (RF) pulses is carried out by a first train of frequency-selective radiofrequency (RF) pulses to create a first spatial encoding along one direction followed by a second train of frequency-selective radiofrequency (RF) pulses to create additional spatial encodings along a different geometry.
65. Apparatus of claim 53 wherein the means for applying a train of frequency-selective radiofrequency (RF) pulses is carried out by a first train of frequency-

selective radiofrequency (RF) pulses to create a first spatial encoding along one direction followed by a second train of frequency-selective radiofrequency (RF) pulses to create additional spatial encodings along a different direction and geometry.

66. Apparatus of claim 53 wherein the means for applying a train of frequency-selective radiofrequency (RF) pulses) is carried out by a first train of frequency-selective radiofrequency (RF) pulses to create a first spatial encoding along one direction followed by additional trains of frequency-incremented radiofrequency (RF) pulses to create additional spatial encodings along different directions.

67. Apparatus of claim 53 wherein the means for applying a train of frequency-selective radiofrequency (RF) pulses is carried out by a first train of frequency-selective radiofrequency (RF) pulses to create a first spatial encoding along one direction followed by additional trains of frequency-selective radiofrequency (RF) pulses to create additional spatial encodings along different geometries.

68. Apparatus of claim 53 wherein the means for applying a train of frequency-selective radiofrequency (RF) pulses is carried out by a first train of frequency-selective radiofrequency (RF) pulses to create a first spatial encoding along one direction followed by additional trains of frequency-selective radiofrequency (RF) pulses to create additional spatial encodings along different directions and geometries.

69. Apparatus of claim 53 wherein multiple distinctive spatial encodings are created.

70. Apparatus of claim 53 wherein spatially-localized MRI information is retrieved in combination with multidimensional NMR spectra by means of further numerical manipulations on the single scan (or few scans) data.

71. Apparatus for the real-time monitoring of a chemical or biochemical process comprising (1) means for conducting a chemical or biochemical process in real-time; (2) means for monitoring the on-going chemical or biochemical process in real time by repeatedly acquiring a series of multidimensional spectra within a single scan implemented at preselected short time intervals; each single scan being carried out comprising (3) means for partitioning, at least notionally, a sample of the on-going chemical process into a set of independent subensembles; (4) means for applying the single scan to the sample by exciting the set of subensembles by a time-incremented series of polychromatic

sequences; (5) means for generating a signal from each subensemble with a final, homogeneous sequence; (6) means for simultaneously acquiring the subensemble-resolved spectral signals for each preselected short time interval; and (7) means for processing such series of signals into a series of multidimensional spectra, so as to visualize the nature of the chemical or biochemical process in a real time fashion.

72. Apparatus for enhancing the sensitivity of unidimensional heteronuclear acquisitions comprising: (1) means for partitioning, at least notionally, a sample into a set of independent subensembles; (2) means for endowing each subensemble with a time-incremented series of evolutions utilizing polychromatic sequences in combination with field gradients; (3) means for transferring the encoded information back to more sensitive NMR nuclei such as protons for the sake enhancing the sensitivity of the detection; (4) means for generating a coherent signal from the heteronuclei by applying a suitable sequence on the more sensitive nucleus; and (5) means for processing such series of signals into the desired spectrum, so as to visualize the NMR behavior of the low frequency heteronucleus with the sensitivity of the directly detected spin.

73. Apparatus for compensating magnetic field inhomogeneities or magnetic field instabilities comprising: (1) means for partitioning, at least notionally, a sample into a set of independent subensembles; (2) means for endowing each subensemble with a time-incremented series of evolutions utilizing polychromatic sequence; (3) means for correcting the static or dynamic distortions in magnetic field ideality by compensating this information, mapped prior to the experiment's execution and/or in a real-time fashion, by a suitable manipulation of the radiofrequency (RF) phases involved in the polychromatic irradiation; (4) means for generating a coherent signal from all nuclei in the sample thus devoid from the deficiencies in magnetic field; (5) means for processing such series of signals into the desired high resolution uni- or multi-dimensional NMR spectra.

74. Apparatus for the real-time monitoring of hyperpolarized spin states comprising (1) means for generating very highly polarized spin states in a sample in real-time; (2) means for monitoring the on-going very highly polarized spin states in the sample in real time by repeatedly acquiring a series of multidimensional spectra within a single scan implemented at preselected short time intervals;

each single scan being carried out comprising (3) means for partitioning, at least notionally, the sample containing the on-going very highly polarized spin states into a set of independent subensembles; (4) means for applying the single scan to the sample by exciting the set of subensembles by a time-incremented series of frequency-shifted sequences; (5) means for generating a signal from each subensemble with a final, homogeneous sequence; (6) means for simultaneously acquiring the subensemble-resolved spectral signals for each preselected short time interval; and (7) and means for processing such series of signals into a series of multidimensional spectra, so as to visualize the nature of the very highly polarized spin states in the sample in a real time fashion.

75. Apparatus for the real-time monitoring of an analyte flowing through a spectrometer comprising (1) means for monitoring an on-going chromatographic process in real time by repeatedly acquiring a series of multidimensional spectra within a single scan implemented at preselected short time intervals; each single scan being carried out comprising (2) means for partitioning, at least notionally, a sample of the analyte of the on-going chromatographic process into a set of independent subensembles; (3) means for applying the single scan to the sample by exciting the set of subensembles by a time-incremented series of polychromatic sequences; (4) means for generating a signal from each subensemble with a final, homogeneous sequence; (5) means for simultaneously acquiring the subensemble-resolved spectral signals for each preselected short time interval; and (6) means for processing such series of signals into a series of multidimensional spectra, so as to visualize the nature of the analyte in a real time fashion.

76. Apparatus for the real-time monitoring a combinatory chemical process comprising (1) means for monitoring an on-going combinatory chemical process in real time by repeatedly acquiring a series of multidimensional spectra within a single scan implemented at preselected short time intervals; each single scan being carried out comprising (2) means for partitioning, at least notionally, a sample of the on-going combinatory chemical process into a set of independent subensembles; (3) means for applying the single scan to the sample by exciting the set of subensembles by a time-incremented series of polychromatic sequences; (4) means for generating a signal from each subensemble with a

final, homogeneous sequence; (5) means for simultaneously acquiring the subensemble-resolved spectral signals for each preselected short time interval; and (6) means for processing such series of signals into a series of multidimensional spectra, so as to visualize the nature of the combinatory chemical process in a real time fashion.

77. Apparatus for the real-time control of a quantum computing process with respect to a sample comprising (1) means for monitoring an on-going quantum computing process in real time by repeatedly acquiring a series of multidimensional spectra within a single scan implemented at preselected short time intervals; each single scan being carried out comprising (2) means for partitioning, at least notionally, a sample correlated with the activity of the on-going quantum computing process into a set of independent subensembles; (3) means for applying the single scan to the sample by exciting the set of subensembles by a time-incremented series of polychromatic sequences; (4) means for generating a signal from each subensemble with a final, homogeneous sequence; (5) means for simultaneously acquiring the subensemble-resolved spectral signals for each preselected short time interval; (6) means for processing such series of signals into a series of multidimensional spectra, so as to visualize the nature of the quantum computing process in a real time fashion, and (7) means for controlling the operation of the quantum computing process using the series of multidimensional spectra.

78. Apparatus for the real-time elucidation of molecules comprising (1) means for acquiring a series of multidimensional spectra within a single scan implemented at a preselected short time interval; said single scan being carried out comprising (2) means for partitioning, at least notionally, a sample of a target molecule into a set of independent subensembles; (3) means for applying the single scan to the sample by exciting the set of subensembles by a time-incremented series of polychromatic sequences; (4) means for generating a signal from each subensemble with a final, homogeneous sequence; (5) means for simultaneously acquiring the subensemble-resolved spectral signals for said preselected short time interval; and (6) means for processing said signals into a multidimensional spectra, so as to visualize the nature of the molecule in a real time fashion.

79. Apparatus for conducting in real-time *in vivo* spectroscopy comprising (1) means for repeatedly acquiring a series of multidimensional spectra within a single scan

implemented at a preselected short time interval; each single scan being carried out comprising (2) means for partitioning, at least notionally, an *in vivo* sample into a set of independent subensembles; (3) means for applying the single scan to the sample by exciting the set of subensembles by a time-incremented series of polychromatic sequences; (4) means for generating a signal from each subensemble with a final, homogeneous sequence; (5) means for simultaneously acquiring the subensemble-resolved spectral signals for said preselected short time interval; and (6) means for processing such series of signals into a series of multidimensional spectra, so as to visualize the nature of the *in vivo* sample in a real time fashion.

80. Apparatus for the real-time monitoring of an MRI protocol comprising (1) monitoring an on-going MRI protocol in real time by repeatedly acquiring a series of multidimensional spectra within a single scan implemented at preselected short time intervals; each single scan being carried out comprising (2) means for partitioning, at least notionally, a sample of the object of the MRI protocol on-going into a set of independent subensembles; (3) means for applying the single scan to the sample by exciting the set of subensembles by a time-incremented series of frequency-shifted sequences; (4) means for generating a signal from each subensemble with a final, homogeneous sequence; (5) means for simultaneously acquiring the subensemble-resolved spectral signals for each preselected short time interval; and (6) means for processing such series of signals into multidimensional spectra, so as to visualize the nature of the on-going MRI protocol in a real time fashion.